Fatigue and Alertness in the United States Railroad Industry Part I: The Nature of the Problem

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ABSTRACT

The railroad industry must actively manage employee fatigue and alertness problems to maintain an optimal level of operational safety and productivity. Given the necessity to operate nights and irregular hours, weekends and holidays under a wide range of physical conditions and service demands, we must explore every reasonable avenue to ensure employees are fit, alert, and well-rested. Effective fatigue management programs must address train crews, dispatchers, signalmen, track workers, and others – both operating and non-operating personnel. Work scheduling is a particular problem in on-call operations because of start-time variability, "call" predictability, and the common use of "shorter-than 24-hour work/rest schedules." Extensive night operations are incompatible with normal circadian rhythms. Staffing limitations often require extensive overtime and reduce the effectiveness of any work schedule. These and other institutional factors significantly contribute to employee sleep deficit and overall fatigue. Lack of alertness and reduced vigilance are related not only to sleep disruption and resulting sleep deficits, but also to cognitive workload, workload transition, the physical working environment, and the design of advanced control systems. Ongoing research into fatigue mitigation and alertness enhancement strategies and into advanced technologies such as Positive Train Control can lead to improvements. These include better labor-management agreements, more effective fatigue-related educational programs, improved schedule regularity, and more practical and adaptable federal laws and regulations.

Key words

Hours of service, sleep patterns; split shift, work rest cycles, vigilance, alerters

Return to Top

BACKGROUND

In a 1999 speech, U.S. Secretary of Transportation Rodney Slater stated, "We know that alertness is a key to safe vehicle operation. To reduce crashes and accidents and their personal and financial consequences, we need to ensure that vehicle operators are ready and capable of operating their vehicles or other transportation equipment." In testimony before the Senate Subcommittee on Surface Transportation and Merchant Marine 22 on September 16, 1998, the Administrator of the Federal Railroad Administration (FRA), Jolene Molitoris, stated, "About one-third of train accidents and employee injuries and deaths are caused by human factors. We know fatigue underlies many of them."

Return to Top

U.S. FEDERAL LAWS REGULATING RAILROAD WORKERS WORK/REST CYCLES

In the United States, fatigue and its impact on alertness in the railroad industry has been viewed with concern for many years. The (U.S.) Hours of Service Act (law), was originally enacted in 1907 and substantially revised in 1969 (and formerly codified at 45 United States Code Sections 61-64b). This law was "intended to promote the safety of employees and travelers upon railroads by limiting the hours of service of certain railroad employees." Section 2 (45 United States Code Section 62) made it unlawful for a common carrier, its officers, or agents to require or permit "an employee" to go, or remain on, duty unless certain restrictions on maximum duty hours and minimum periods off duty were met. Section 3 (45 United States Code Section 63) states that "no operator, dispatcher, or other employee" engaged in "train order service" could be required, or permitted to go, or remain, on duty in violation of specific limitations.

A summary of the regulations is as follows. For "train and engine service," a railroad carrier and its officers and agents may not require or allow an employee to remain or go on duty after 12 continuous hours on duty, or 12 hours in broken service in a 24-hour period starting at beginning of work tour; or at the end of that 24-hour period, if there has not been at least eight consecutive hours of off-duty time even if the employee had fewer than 12 hours on duty. The minimum off-duty periods are eight or 10 consecutive hours, depending on whether 12 continuous hours were worked. There is a 4-hour minimum for interim rest period.

For "signal service," where employees are engaged in installing, maintaining, or repairing signal systems, limitations and minimum off-duty periods are generally the

same as "train and engine service," but better defined in statute. Due to basic differences in the nature of service, there are unique provisions, the most important of which are concerned with trouble calls. With regard to off-duty time: at least 30 minutes and up to 60 of return travel counts as time off duty, but this brief period does not break continuity of duty. Release periods of "more than one hour" are considered to break continuity.

For "train order service," where an employee transmits or receives orders pertaining to or affecting train movements (especially dispatchers and operators), work must cease after: nine hours on duty in any 24-hour period where two or more shifts are employed; or 12 hours in one-shift operation. There is an exception of four extra hours for an emergency, but no more than three times in a seven-day period.

In 1992, Congress enacted the Rail Safety Enforcement and Review Act, Public Law 102-365, 106 Statute 972. This act added clarifying language, "Any person (including but not limited to a railroad; any manager, supervisor, official, or other employee or agent of a railroad; any owner, manufacturer, lessor, or lessee of railroad equipment, track, or facilities; any independent contractor providing goods or services to a railroad; and any employee of such owner, manufacturer, lessor, lessee, or independent contractor) that requires or permits any employee to go, be, or remain on duty in violation of section 2, section 3, or section 3A of this Act, shall be liable for a penalty. . . ."

In 1994 Congress repealed the Act and simplified and recodified it primarily as chapter 211 of Title 49 of the U.S. Code. The recodification merely changed the location in the U.S. Code of the transportation laws and altered some of the language, and did not make any substantive changes.

Return to Top

FATIGUE AND SAFETY

The National Transportation Safety Board (NTSB) is an independent Federal agency charged by Congress with investigating every civil aviation accident in the United States and significant accidents in the other modes of transportation -- railroad, highway, marine and pipeline -- and issuing safety recommendations aimed at preventing future accidents. While the recommendations of NTSB are considered unbiased and thorough, they do not always result in changes in policy or regulation. The NTSB findings are reported throughout this paper to enhance the reader’s technical understanding of crashes and accidents attributable to fatigue.

According to a NTSB (1999) analysis of FRA data from January 1990 to February 1999, only 18 cases were coded "operator fell asleep" as a causal or contributing factor. The NTSB believes that 18 cases in more than nine years underestimates the actual number of cases in which fatigue might have been involved. It is the opinion of the NTSB that accidents coded by the FRA as resulting from "failure as to comply with signals" may actually be fatigue related.

The NTSB notes that railroad hours-of-service laws prescribe only maximum hours on duty and a minimum amount of rest in a 24-hour period. They do not take into account (1) how human circadian rhythms interact with the time of day when the work/rest periods take place, (2) the cumulative effects of working an unlimited number of successive days, or (3) the long-term health effects of various work/rest schedules.

Return to Top

ISSUES SPECIFIC TO RAILROAD OPERATIONS

There are several aspects of railroad operations that can cause fatigue and alertness problems: the irregularity of work schedules in freight operations, the need for split-shifts in commuter and urban operations, and the high potential for complacency and boredom in some freight operations.

Freight and passenger rail operations both are conducted 24 hours per day, but freight service has a relatively higher proportion of night operations. The irregularity and unpredictability of shift start times are particularly serious problems in freight operations. Scheduling is based on the availability of goods, the availability of crew and rolling stock, and the priority on delivery time. From the point of view of the engineer, start time is usually irregular and highly unpredictable. Factors such as weather, equipment breakdown, and maintenance-of-way problems also result in irregular work completion.

Railroad crews are known to work work/rest schedules that are less than 24 hours in length. (Pilcher and Coplen, 1999). During such schedules the train crew’s work often starts two or more hours earlier each day. During periods of high demand engineers may work 18 or even 16-hour schedules. For instance, an engineer may legally work 11 hours and 59 minutes, be given eight hours off, and then return to work resulting in a 20 hour schedule. Alternatively, an engineer can legally work eight hours and rest for eight hours resulting in a 16 hour schedule. Such less-than–24-hour schedules provide clear benefits to both the railroad and the employee. They permit the railroad to make more flexible and intensive use of crew time, and they enhance employee income by providing more paid hours than schedules that based on a 24 hour cycle.

However, such schedules impact the ability of the crew to use available rest time for achieving needed sleep. Humans normally have regular circadian rhythms. One major role of these rhythms is to regulate the time of sleep onset. These rhythms are entrained about the normal 24-hour diurnal cycle. Disruption by a factor such as work schedule can seriously limit the ability of an engineer to achieve adequate sleep.

The Sleep Patterns of Engineers

Freight engineers face a number of challenges in getting adequate sleep. Their schedules are both irregular and unpredictable. Work schedules are not likely to coincide with the worker's circadian rhythms or with the schedules of their families or communities. Finally nights spent away from home are sometimes spent in uncomfortable and noisy bunkhouses.

In a study (Pollard, 1996) conducted for the FRA by the Volpe National Transportation Systems Center (Volpe Center), data was gathered from diaries kept by about 200 engineers employed by six major railroads. These diaries recorded such items as: the quantity and quality of their sleep, estimates of their alertness levels at various times while on duty, time on duty, commuting time, and the accuracy of information provided to crews about job-start times.

Figure 1 illustrates the average sleep achieved by the surveyed locomotive engineers compared to the general population. Overall, engineers averaged about seven hours and eight minutes of total sleep per day (about 20 minutes less than the general population, which averages about 7.5 hours). Engineers who happened to work relatively normal daytime hours on a given day tended to get the most sleep. Those whose jobs started at night or ended in the morning got the least sleep.

Figure 2 shows the relationship between the average length of total sleep on a given day and the starting time of the job on that day. Job starts between 2200 and 0300 hours are associated with average total sleep of only about five hours. For jobs that start between 2200 and 0400 hours, or end between 0200 and 1100 hours, sleep averages less than six hours.

Figure 1 Hours of sleep for engineers and general population

Figure 2. The relationship between sleep and job start time for locomotive engineers.

Passenger Operations - Split Shifts

While passenger train crews usually have regular and predictable schedules and sleep at home more often, they too face challenges in getting adequate rest. Crews involved in commuter operations are often required to work a split shift. Split shift schedules

(even those allowed under the Hours of Service Act) impact the ability of the train crew to get appropriate rest. They can result in situations where individuals can work far more than 12 hours in a 24-hour period without an adequate sleep period. The following is an example of an accident where lack of rest due to a split shift may have had a role. The example was drawn from testimony before the Committee on Transportation and Infrastructure Subcommittee on Railroads, U.S. House of Representatives, Regarding Human Factors in Railroad Accidents, March 6, 1996. About 8:40 a.m. Eastern Standard Time, on February 9, 1996, New Jersey Transit Commuter Train 1254, operating eastbound from Waldwick to Hoboken, New Jersey, collided head-on with the lead locomotive of New Jersey Transit Commuter Train 1107. Train 1107 was a westbound train operating between Hoboken, New Jersey and Suffern, New York, and consisted of a diesel locomotive and six passenger cars. The train was configured with the diesel locomotive in front and was staffed by an operating crew of three.

The westbound train was operating on a clear signal and traveling at about 53 miles per hour in an area authorized for 60 miles per hour. The eastbound train left Harmon Cove station, accelerated to 53 miles per hour, reduced speed to 30 miles per hour, then to 19 miles per hour, and impacted the westbound train at about seven miles per hour. Eastbound train 1254 had passed a stop signal and fouled the mainline when the collision took place. (The term "fouled" simply means that the mainline was blocked by the presence of the eastbound train) The engineer of train 1254 was working a split shift. He reported to work at 6:00 p.m. Thursday, and operated trains until about 1:00 a.m. Friday. From 1:00 a.m. until 5:40 a.m., when he went back on duty operating trains, he rested, using seats in passenger coaches of the train to sleep. He was scheduled to get off work at 7:30 a.m., but he worked overtime and was assigned to operate one more train. He "dead headed" to Waldwick, New Jersey, and operated the accident train from Waldwick to the collision site. The term "dead headed" means that during the return to Waldwick he was not operating the train, but not legally in a rest status. The investigation revealed that this crew had been on this schedule all week as well as the previous week. The engineer had worked this schedule for more than three years at the time of the accident. The NTSB noted that "The Hours of Service Act, . . . allows train engineers to work 12-hour duty periods. Thus, the engineer was well within the allowable duty limits. The Hours of Service Act allows the maximum 12-hour duty period to be interrupted (split) by a rest period of at least four hours after which the remainder of the 12-hour duty period may be completed. This allows railroads to have the services of a crew for up to 16 hours at a time."

Passenger Operations - Transition Between "Normal" Schedule and Night Schedule

The NTSB (1996) reviewed a "Collision Involving Two New York City Subway Trains on the Williamsburg Bridge in Brooklyn, New York, June 5, 1995." In this

collision one person was killed and 69 people were treated at area hospitals for minor injuries. The total estimated damages exceeded $2.3 million. A major cause of the accident was "The J train operator failed to take action to stop his train on the Williamsburg Bridge because he was asleep." The following table illustrates his work/rest schedule prior to the accident. The data shows he had only between three, and 6.5 hours of noncontiguous sleep in the 24 hours before the Brooklyn accident.

Table 1. Operator's Work/Rest Schedule Prior to the Williamsburg Bridge Collision.

Friday, June 2